

The Next Generation of Computing

Frank Hudziak
Member of Technical Staff
AMD

AMD64 Brand Architecture ...



Customer-Centric Innovation



Your Link To The Future Of Computing



*Value and
Performance
Leader
x86-32*



*Leading
Reduced-Power
Performance
AMD64 Capable*



*Leading
Mainstream
Performance
AMD64 Capable*



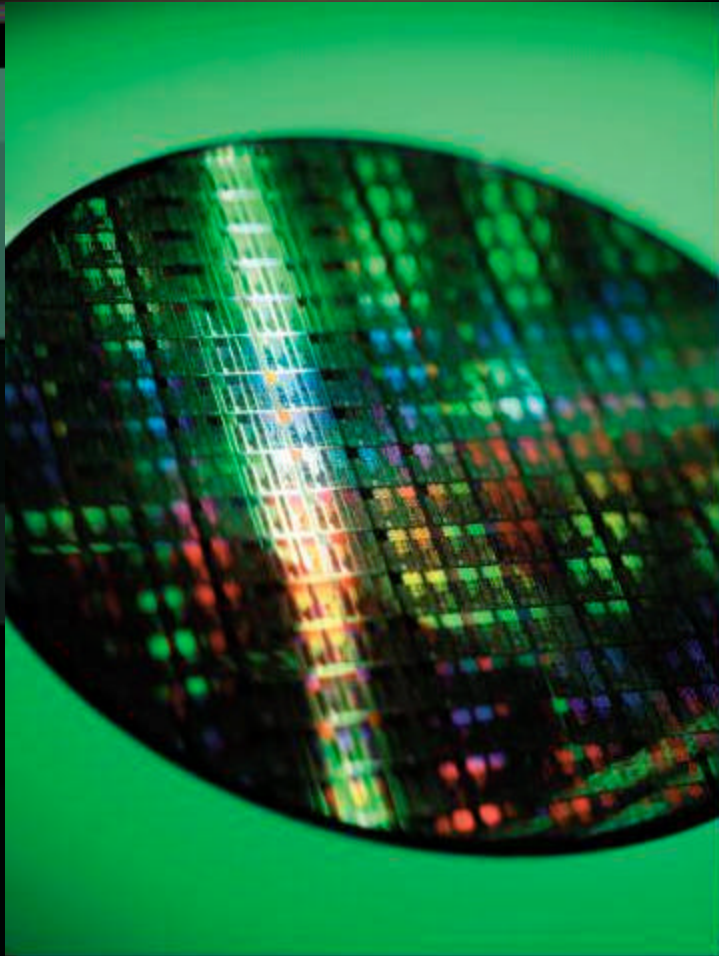
*Prosumer
Dual-Core
Performance*



*"King of the
Hill"
Performance
for
Enthusiasts
and Gamers*



*Enterprise Class
Scalable MP
Performance
on AMD64*



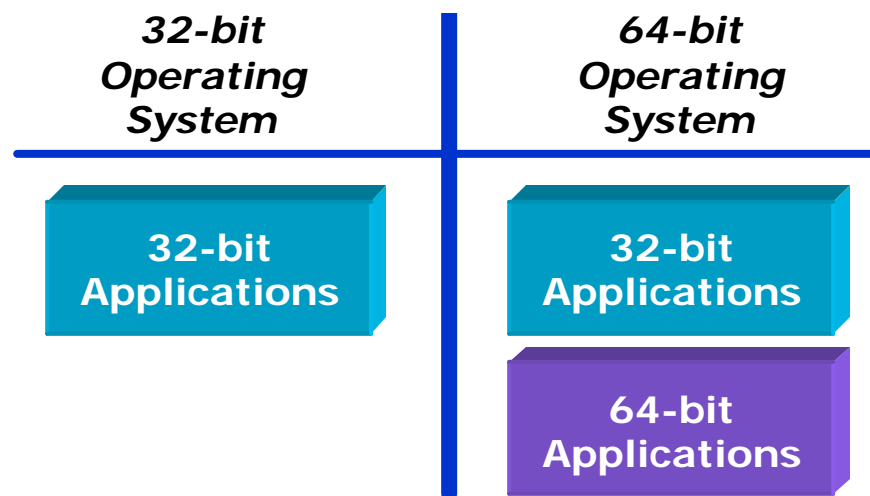
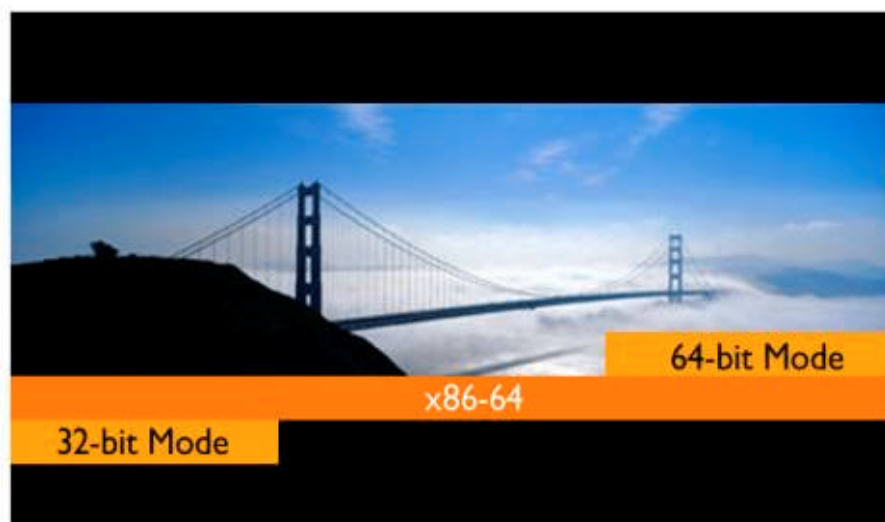
AMD64 Architecture



AMD64 Technology

Simplify Your Customers' Migration to 64-bit Computing

- Adds 64-bit capabilities to the world's highest performing 32-bit core for 2P and 4P servers
- Provides investment protection for users who have invested in 32-bit application software
- Current 32-bit applications will work on today's 32-bit operating systems as well as tomorrow's 64-bit operating systems
- Enables a gradual application transition to 64 bits as required by end user individual needs
- No special hardware or investment in a proprietary infrastructure





Core Architecture

- **x86-64**

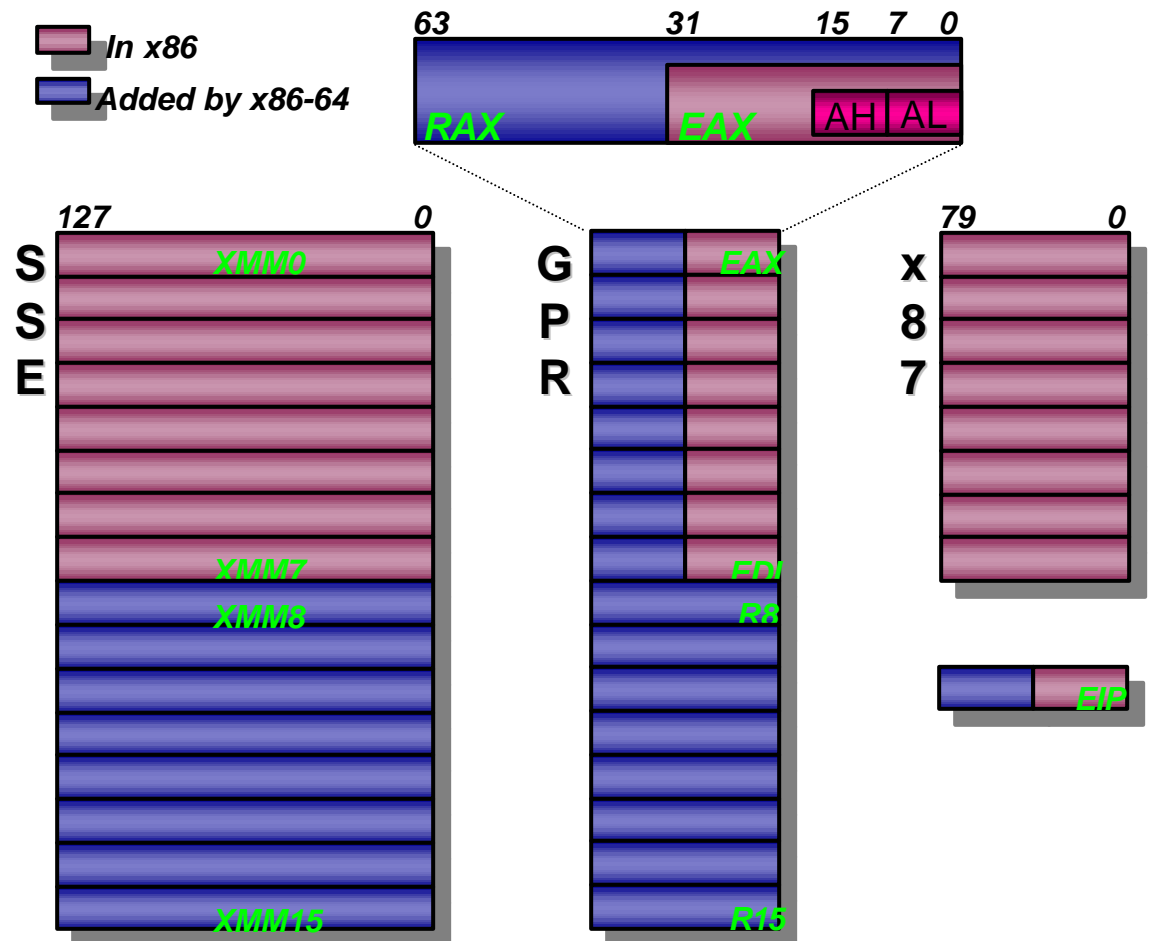
- 64-bit integer registers
- 48-bit Virtual Address
- 40-bit Physical Address

- **REX - Register Extensions**

- Sixteen 64-bit integer registers
- Sixteen 128-bit SSE registers

- **SSE2 Instruction Set**

- New for AMD Athlon™ & AMD Opteron™
- SSE1 already added with AMD Athlon XP





AMD64™ Technology Overview

➤ **Outstanding Performance**

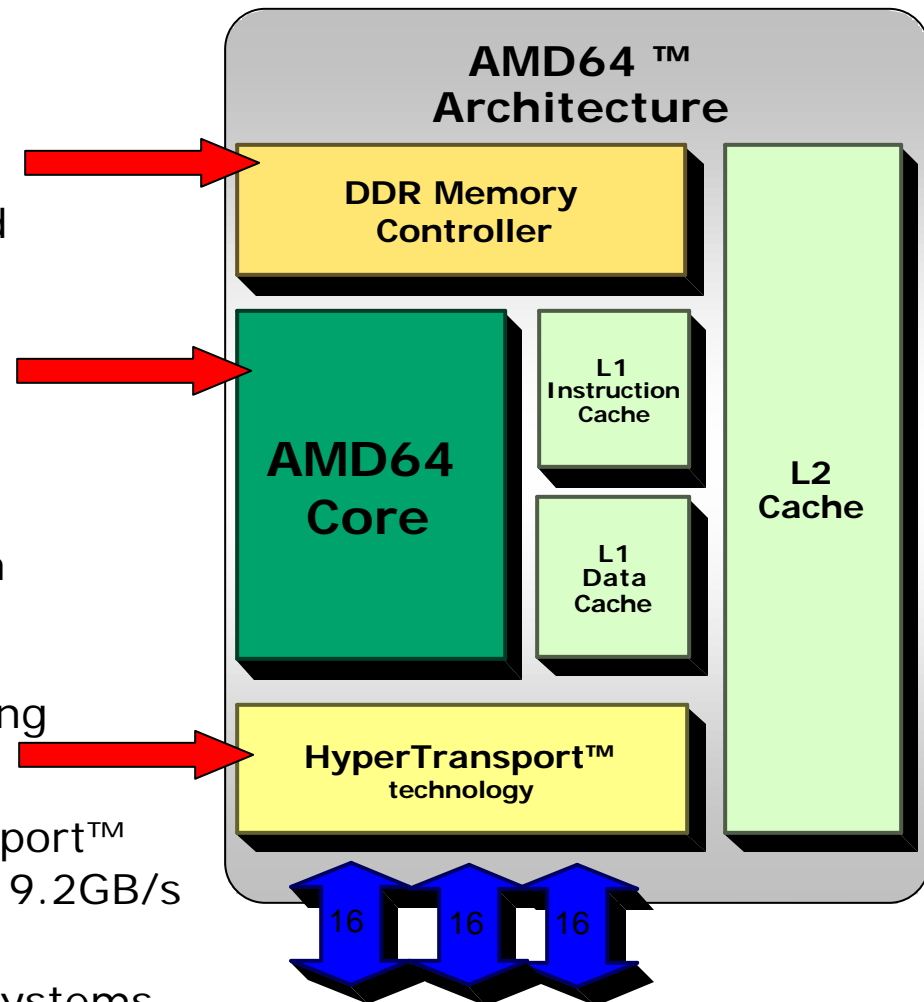
- ✓ High-bandwidth integrated memory controller scales with processor frequency and number of processors

➤ **64-bit Architecture with 32-bit Compatibility**

- ✓ Approximately 10,000 legacy applications at time of launch

➤ **Exceptional Scalability**

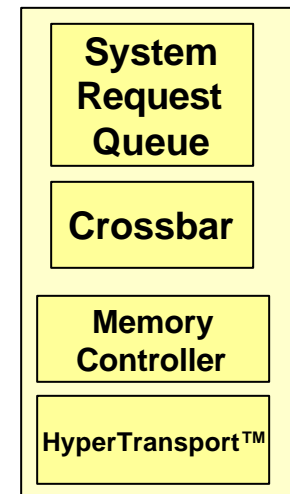
- ✓ Glueless multiprocessor scaling
- ✓ Removes I/O bottlenecks
 - 📄 Three 16-bit HyperTransport™ technology links provides 19.2GB/s peak aggregate bandwidth
- ✓ Reduced costs for high-end systems



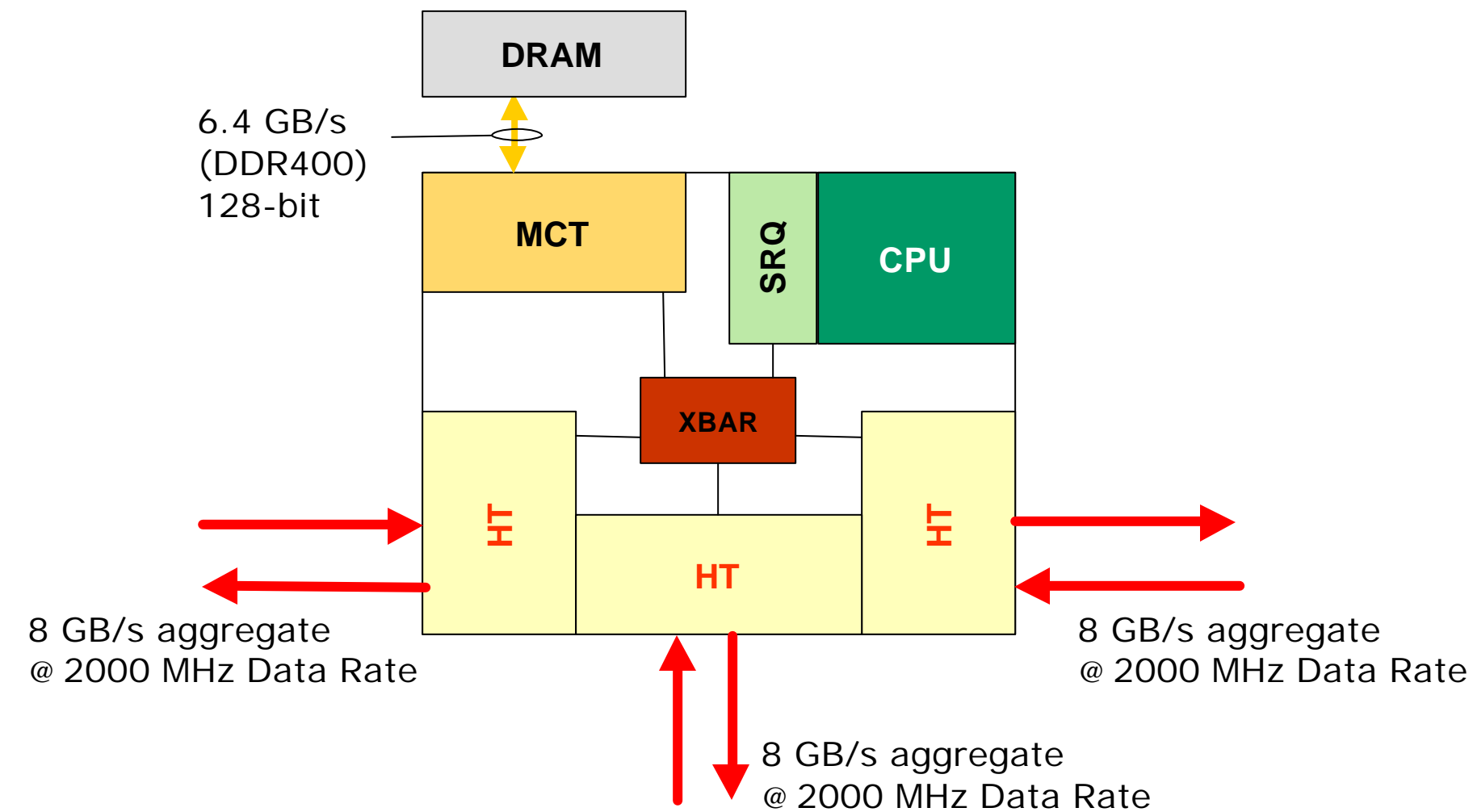


Firmware View of Northbridge

- Performs same functions found in Northbridge
 - Memory Controller – fully integrated
 - Host-Bridge function as defined by the PCI spec
 - PCI to PCI Bridge as defined by the PCI spec
 - Graphics Address Resolution Table (GART)
 - Multi-processor coherency
- Controlled via PCI configuration registers
 - Memory controller configuration
 - HyperTransport™ technology routing
- Configured by Firmware
 - HyperTransport™ initialization via Hardware
 - Auto-size, coherent or non-coherent, “Legacy” path to the ROM in Southbridge
 - HyperTransport™ technology speed and routing via firmware
 - Everything else in firmware follows existing paradigms
 - PCI enumeration
 - Memory sizing and configuration
 - I/O controller setup



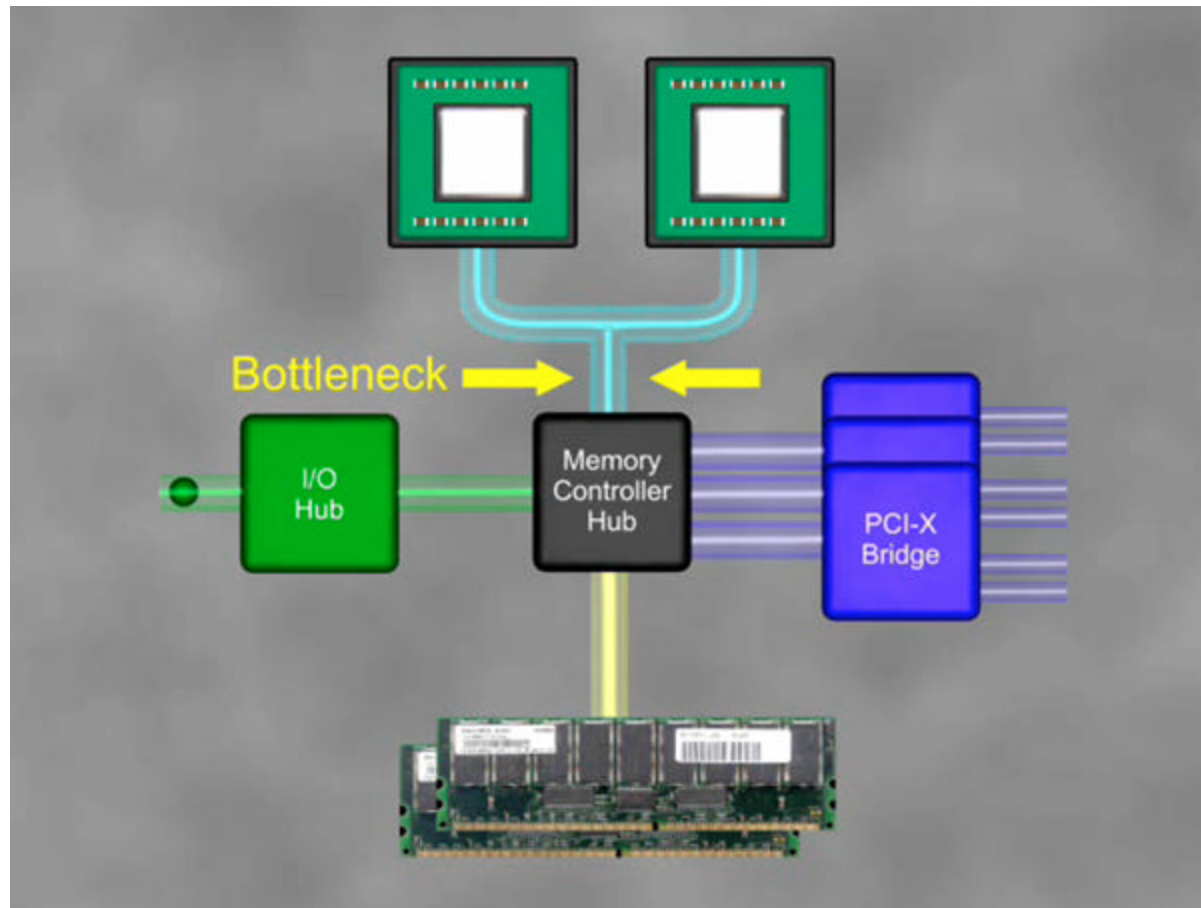
AMD Opteron™ Processor Architecture



HT = HyperTransport™ technology

Dual Xeon Processors

Heavily Loaded



E7501 chipset with DDR266

(2) Xeon = 8.6 GB/s

(3) PCI-X Bus = 3.2 GB/s

I/O Bus = 266 MB/s

Total Demand = 12.1 GB/s

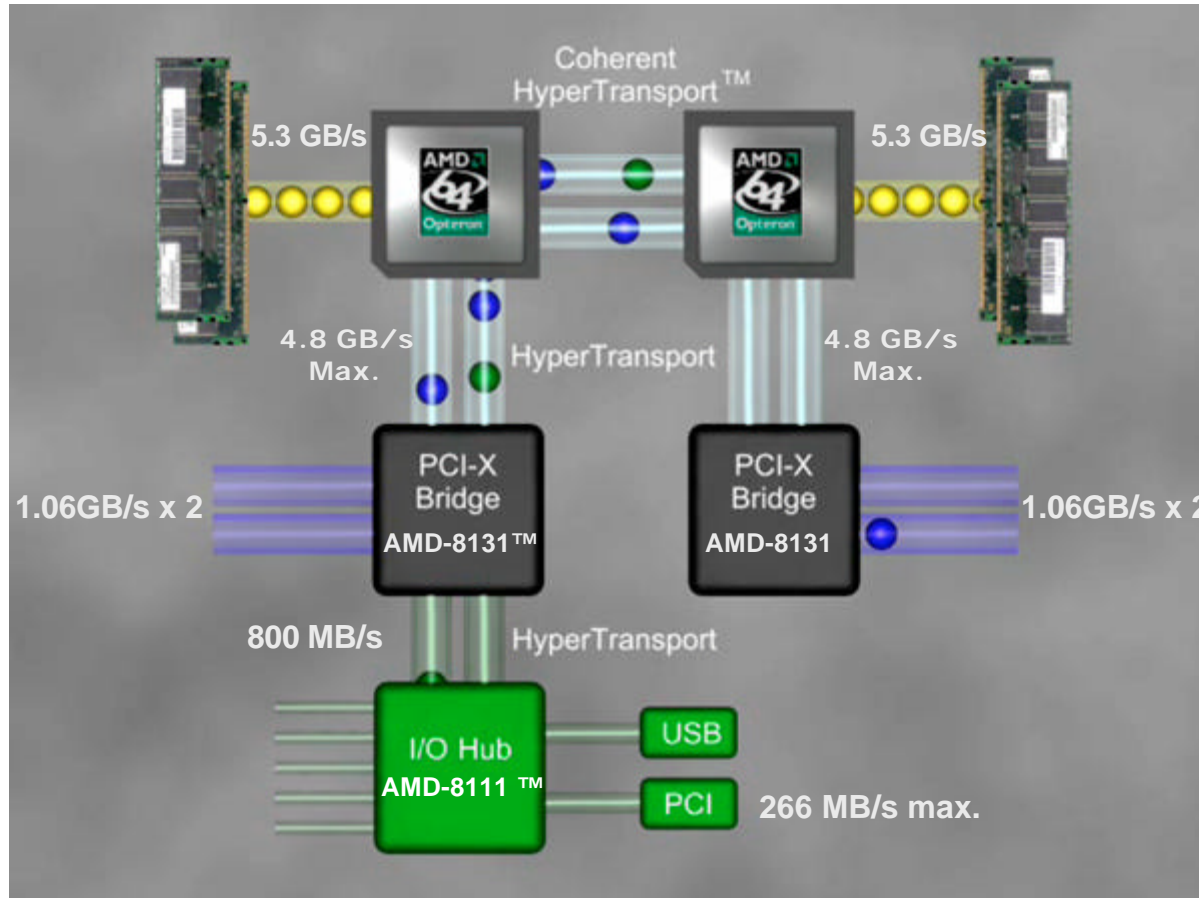
FSB Total Available
533MHz x 8 Bytes
= 4.3 GB/s

FSB is the bottleneck

- Each CPU gets $< \frac{1}{2}$ of max bus bandwidth
- Memory and I/O must share the same bus
- Adding CPUs compounds problems
- Not very scalable

Dual AMD Opteron™ Processors

Heavily Loaded



- **All bottlenecks reduced or eliminated**

- Each CPU has 6.4 GB/s dedicated memory bandwidth
- CPU-to-CPU coherent HyperTransport™ offers bandwidth of 4 GB/s max. each direction
- Each PCI-X Bridge has bandwidth of 2.4 GB/s max. each direction
- I/O is independent of memory access
- Adding CPUs adds memory and I/O bandwidth

AMD-8100™ chipset with DDR400
ECC Registered Memory



Typical Multiprocessing System

- System scalability limited by northbridge

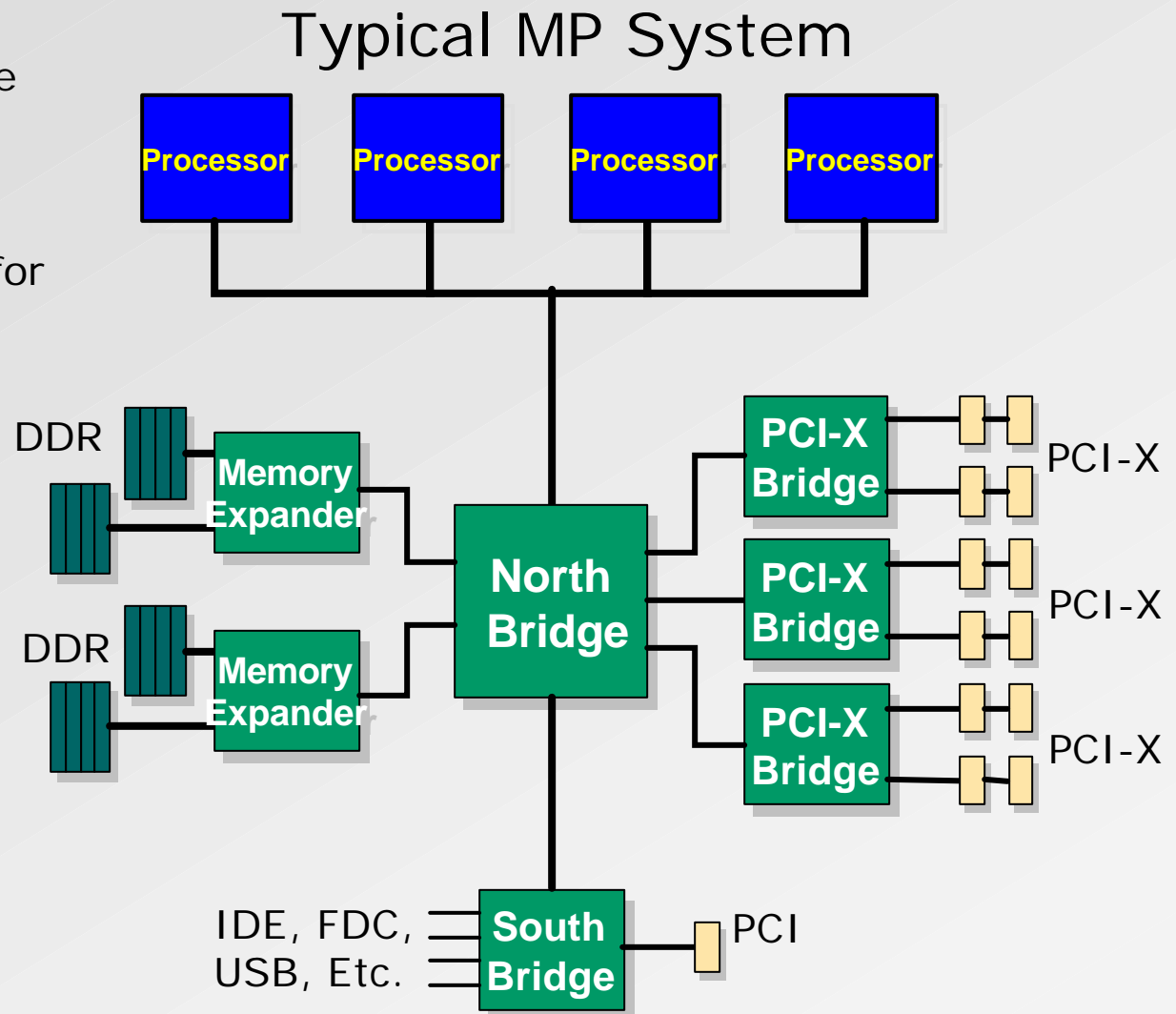
– Max of 4 processors

– Processors compete for FSB bandwidth

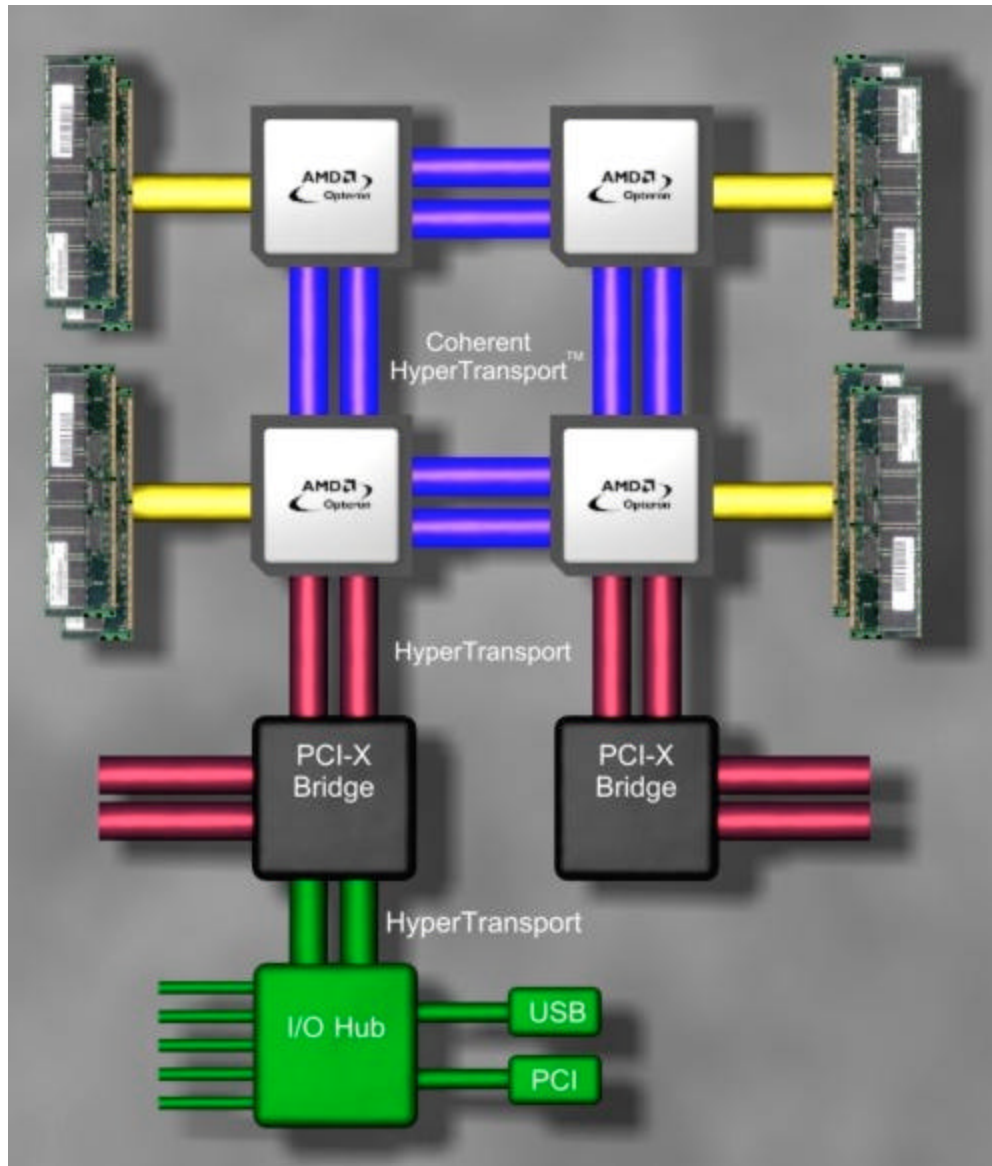
– Memory size and bandwidth are limited

– Max of 3 PCI-X bridges

– Many more chips required

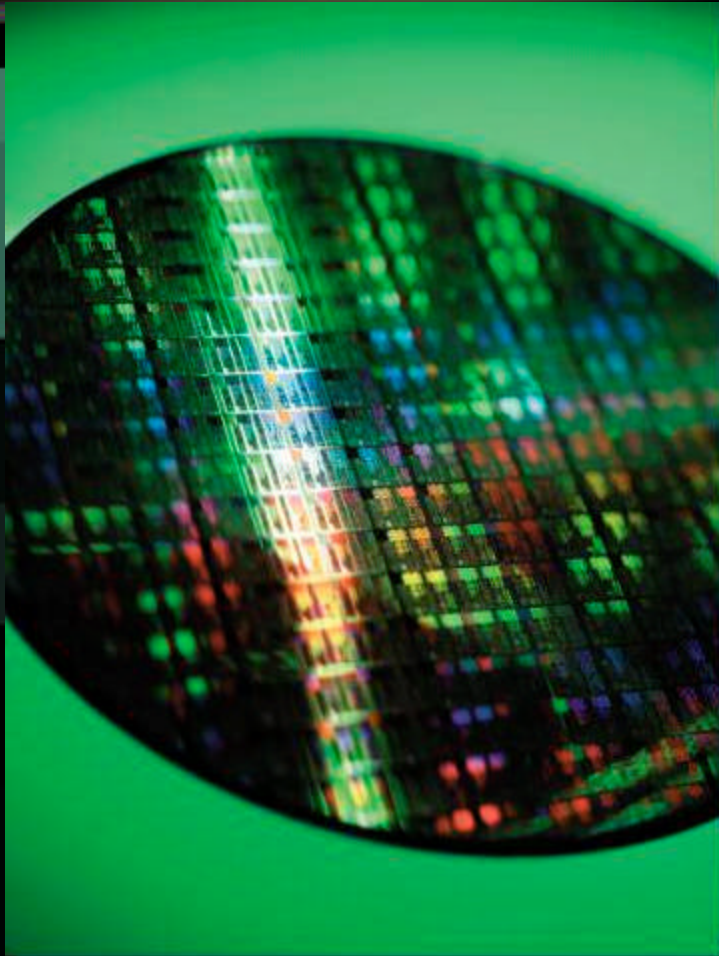


“Glueless” Multi-CPU Design



HyperTransport™:

- Point-to-point link
- Allows for “glueless” multi-CPU designs
- Each CPU adds memory and HyperTransport bandwidth
- Three (coherent capable) HyperTransport links per AMD Opteron™ CPU (8xx Series)
- Scales to an 8-way without additional glue logic



**Additional
Features**



AMD 64 Feature Information

AMD Cool 'n' Quiet™/PowerNow! Technology

AMD Cool 'n' Quiet technology enables processor frequency and voltage switching to reduce power and fan speed

PC MANUFACTURER REQUIREMENTS

Processor requirement:

- **AMD Athlon™ 64 processor**

Platform requirements:

- **BIOS supporting the feature**
- **Platform passing AMD's validation**

Software driver requirements:

- **Supported by Windows XP driver**

Recommended:

- **Heatsink fan capable of speed control**
(All Athlon 64 PIB models have thermally-controlled fans)

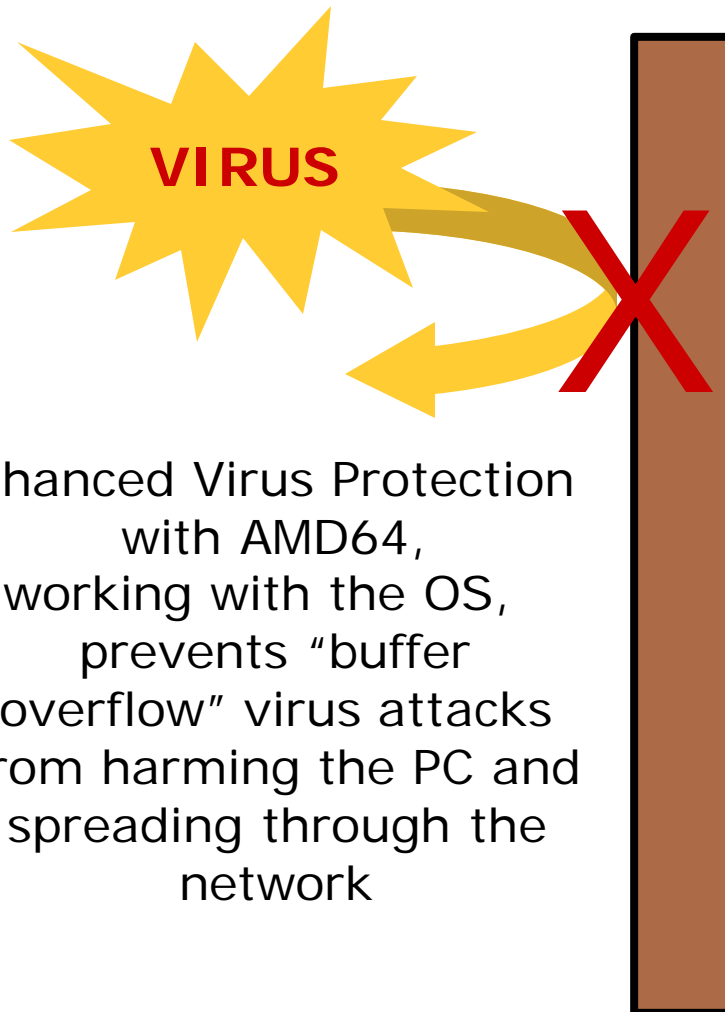
Cool

- ✓ Conserves power by delivering performance on demand to reduce average processor power
- ✓ Reduces PC heat output

Quiet

- ✓ Low-noise work environment by throttling system fans
- ✓ Quiet PCs for educational and office environments, family rooms, dorm rooms, etc.

Enhanced Virus Protection with AMD64



Enhanced Virus Protection with AMD64, working with the OS, prevents "buffer overflow" virus attacks from harming the PC and spreading through the network

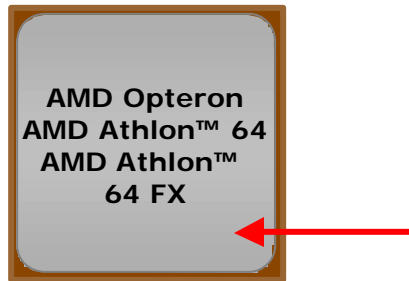
- Enhanced Virus Protection first activated in 32-bit Windows XP with Service Pack 2; expected in 2Q'04
- Enhanced Virus Protection is native to 64-bit Windows XP and Windows "Longhorn" client OS; cannot be circumvented
- Enhanced Virus Protection is not supported by any other desktop processor.

AMD 64 Feature Information

Reliability and Stability Features



Integrated Heat Spreader



THERMAL BENEFIT

- Dissipates the generated heat across the full spreader surface

SIMPLIFIES HEATSINK INSTALLATION

- Uses a thermal paste (or thermal grease) instead of a phase change material (PCM) between the processor and the heatsink
- Protects the processor die from cracking due to improper mounting of the heatsink

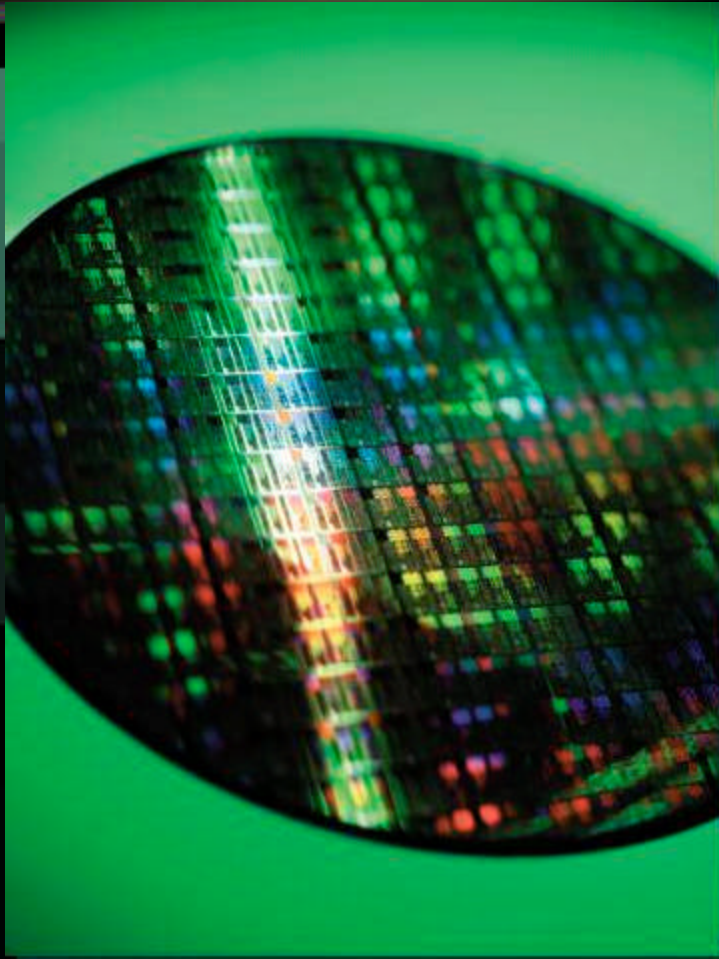
Thermal Monitoring and Protection Features

THERMTRIP

- Shuts down the processor in thermal overrun condition without motherboard intervention

THERMAL DIODE

- Works with motherboard circuitry to monitor CPU temperature and work with thermal control hardware (i.e., temperature controlled fans, etc.)

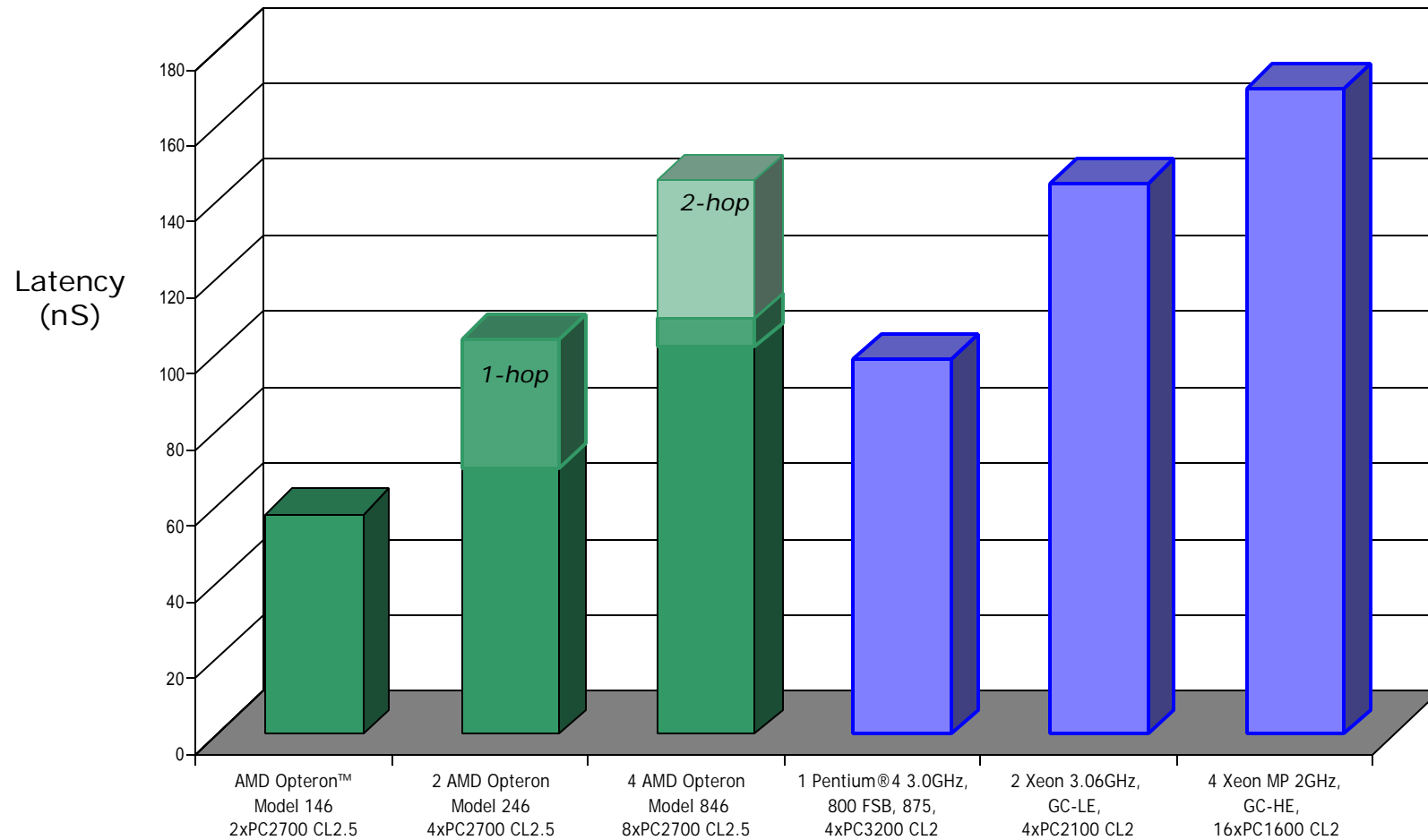


Benchmarks



Low Memory Latency

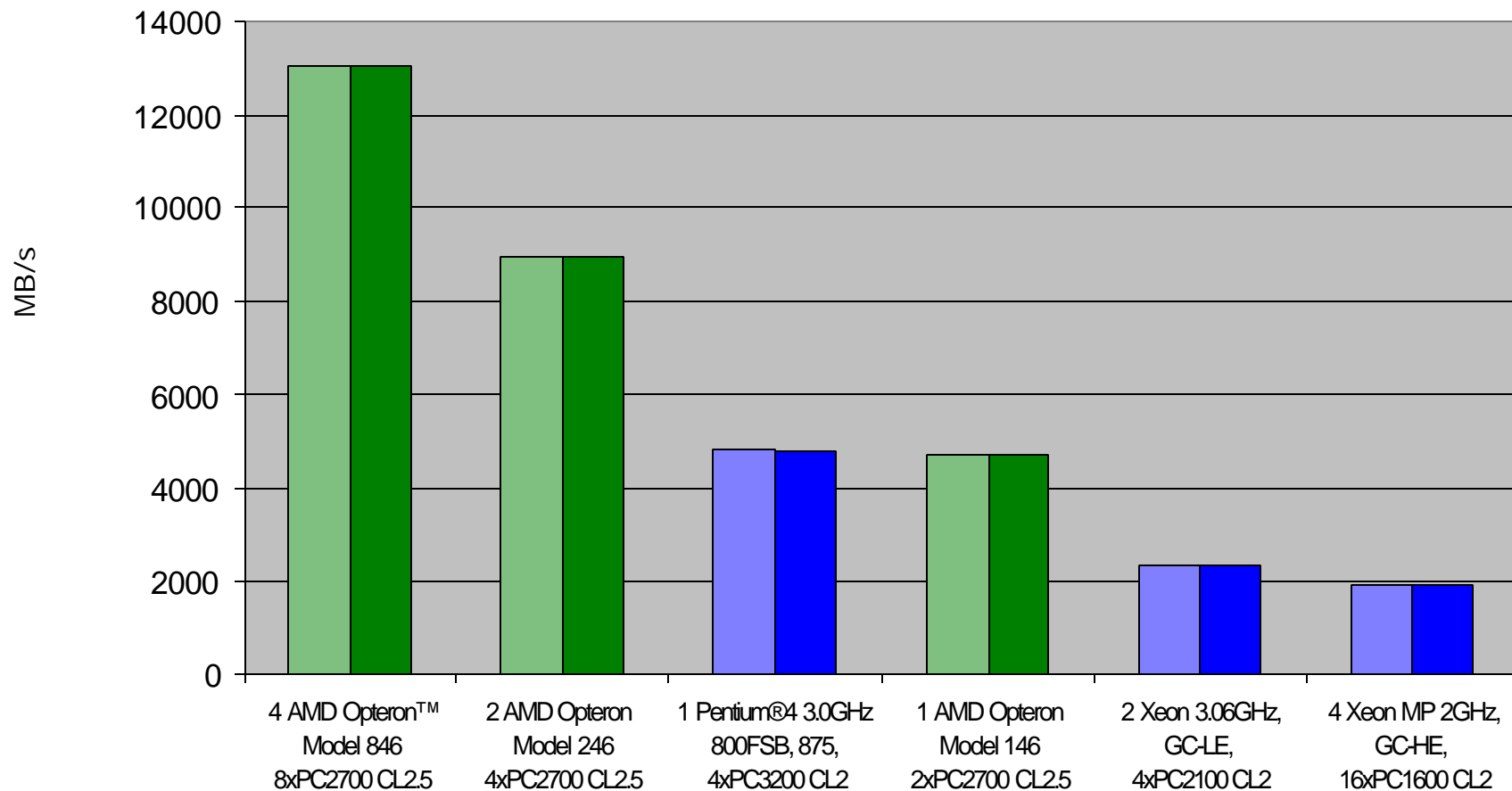
ScienceMark 2.0 Beta, 512-Byte Stride



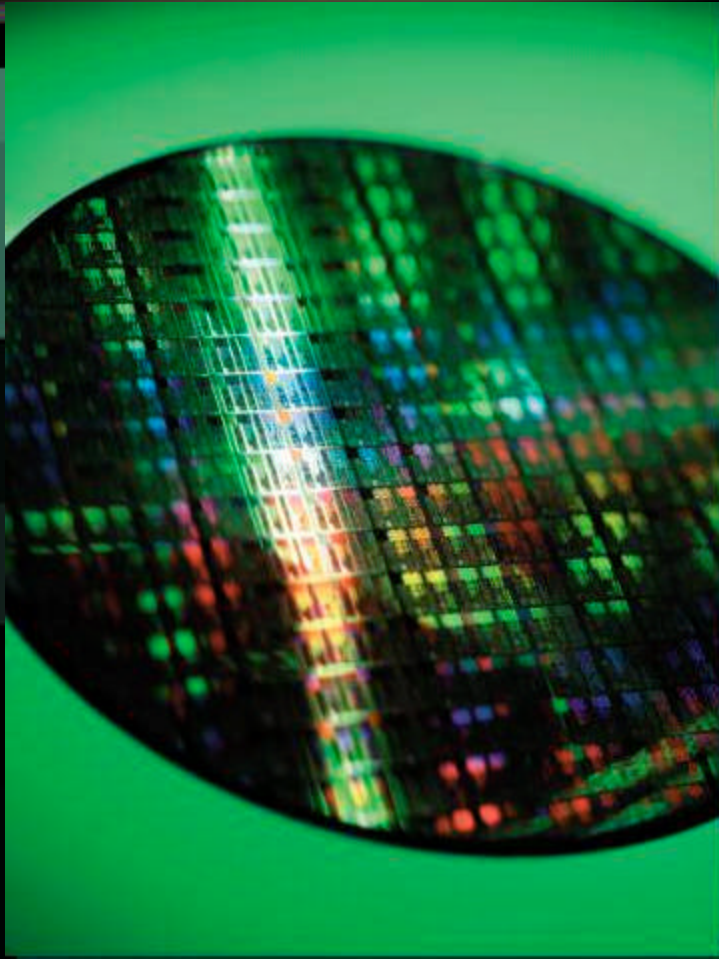
All benchmarks run on Microsoft® Windows® Server 2003 Enterprise Edition

Scalable Memory Bandwidth

SiSoftware Sandra Standard 2003



All benchmarks run on Microsoft® Windows® Server 2003 Enterprise Edition



**Multi-core
Processors Go
Mainstream with
AMD64 Technology**

AMD Vision and Industry Leadership



AMD leads the industry to x86 multi-core processing

- **October 1999** – AMD describes AMD64 extensions, HyperTransport™ technology, & announces multi-core-enabled processor design at MPF.
“AMD plans to deploy multiple x86-64 processors on a single die.”
- **Feb. 2001** – HyperTransport Consortium formed
- **April 2003** – AMD introduces AMD Opteron™ processor, world's first x86-based 64-bit processor
- **August 2004** – AMD demonstrates industry's first x86, dual-core processor on shipping platform

The Heavy Hitters



◆ Frequency is the tide that lifts all boats

- The frequency limitations of x86 have been largely solved
 - Variable length instructions
 - Implicit flags
- Further pipelining will further increase frequency
- New architectures introduce new frequency limiters

◆ Power Limits Frequency

- Excessive speculation wastes power
- Large resources waste power

◆ AMD plans to deploy multiple x86-64 processors on a single die

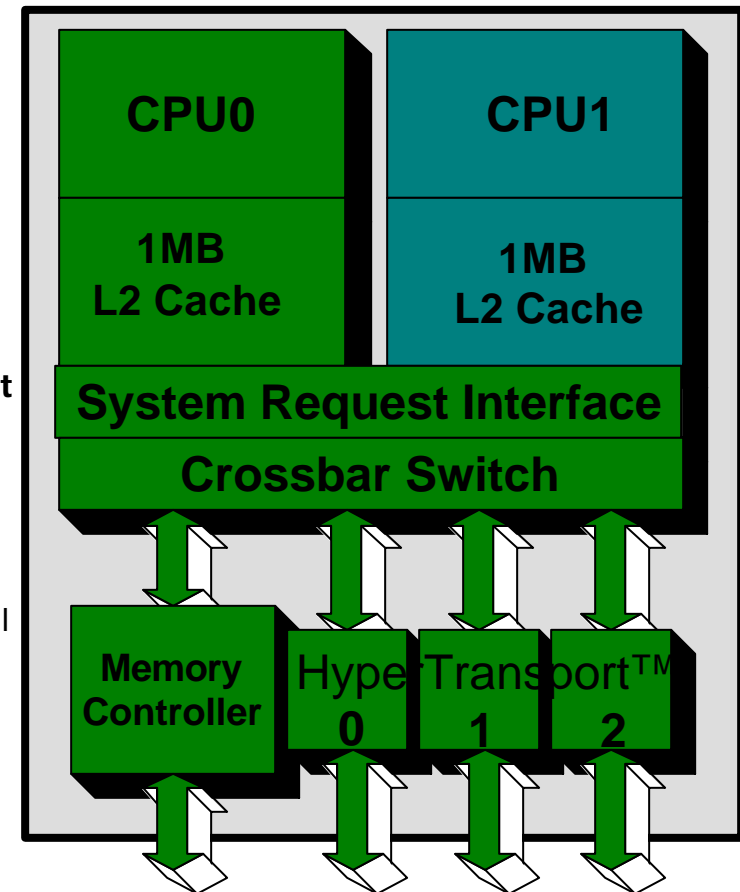
- Multiprocessing is finally real, especially for server applications
- Uniprocessors must have leading performance
- But, they must also be area and power efficient to enable on-die MP

AMD - Microprocessor Forum 1999

Dual-Core AMD Opteron™ Processor Design



- **Two AMD Opteron™ processor cores on a single die**
 - Each with 1MB L2 cache
- **Shared Northbridge**
 - Three HyperTransport™ technology links
 - Dual-channel (128 bit) DDR interface
- **AMD Opteron processor designed as CMP from the start**
 - 2nd port on SRI, request management, 2 APICs, clocking microcode
- **Two complete CPUs**
 - Symmetric multiprocessor programming (SMP) model
 - Simpler, less restrictive programming model than 'virtual CPU' approach
- **AMD Direct Connect Architecture**
 - Everything connected directly to CPU
 - Reduces system architecture bottlenecks
 - Further reduces latency by directly connecting two cores on same die



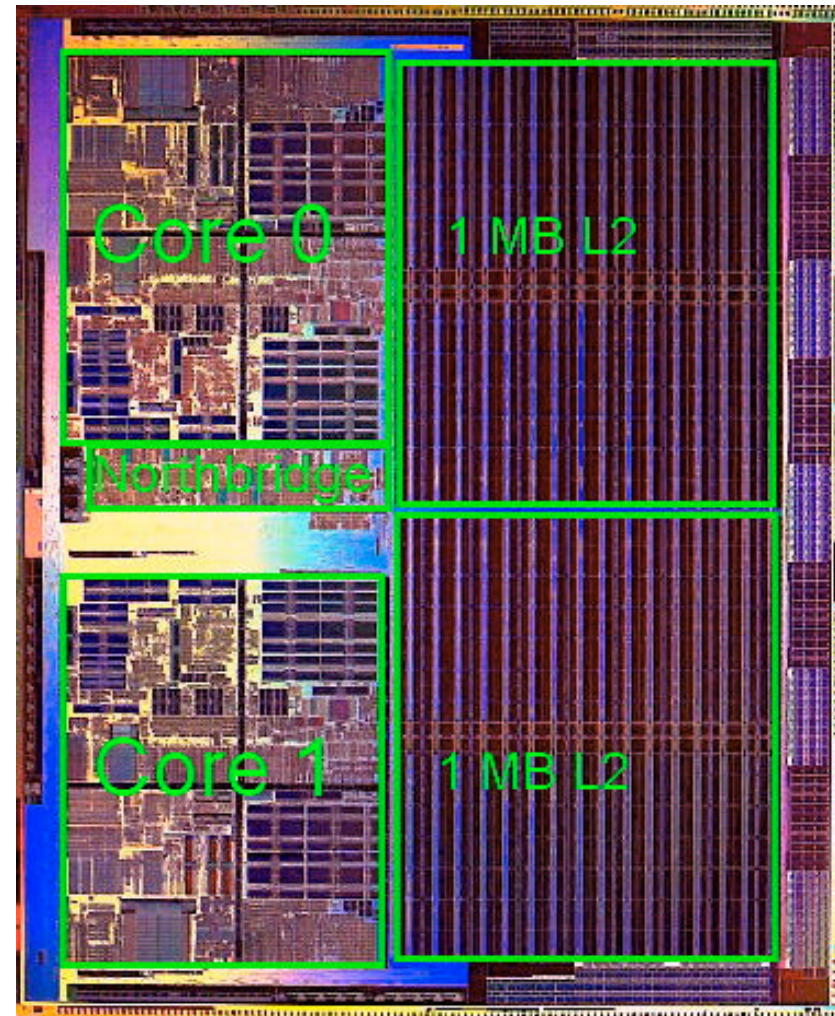
Existing AMD Opteron™ Processor Design



AMD64 Dual-Core Physical Design

- **90nm**
 - Approximately same die size as 130nm single-core AMD Opteron™ processor*
 - ~205 million transistors*
- **95 watt power envelope**
 - Fits into 90nm power infrastructure
- **940 Socket compatible**

**Based on current revisions of the design*





AMD Embedded AMD64

Product Roadmap







AMD64 Brand Architecture ...



Customer-Centric Innovation



Your Link To The Future Of Computing

					
<i>Value and Performance Leader x86-32</i>	<i>Leading Reduced-Power Performance AMD64 Capable</i>	<i>Leading Mainstream Performance AMD64 Capable</i>	<i>Prosumer Dual-Core Performance</i>	<i>Mainstream Computing on AMD64</i>	<i>Enterprise Class Scalable MP Performance on AMD64</i>

AMD Opteron™ Processor Product Positioning



- *Excellent for high-end embedded applications*
- *Supports 32 and 64-bit applications*
- *Up to three coherent HyperTransport™ technology links*
- *Ultimate AMD64 implementation*

Positioning Statement

AMD Opteron™ processors are the ultimate implementation of AMD64 technology. From 1P single core to 4P+ dual core, AMD Opteron processors bring AMD64 performance to high-demand embedded applications. This processor provides enhanced security, 64-bit capability, and dual core performance for high-bandwidth and high performance applications.

AMD Turion™ 64 Mobile Technology Product Positioning



- *Excellent for embedded applications*
- *Supports 32 and 64-bit applications*
- *Optimized for low-power operation*
- *Based on AMD64 architecture*

Positioning Statement

AMD Turion™ 64 Mobile Technology is uniquely optimized to deliver AMD64 performance in portable or embedded applications. This processor provides enhanced security, 64-bit capability, and AMD PowerNow!™ Technology for optimized power management and performance on demand.

AMD Sempron™ Processor

Product Positioning



- *Ideal value solution for embedded applications*
- *32-bit performance processor*
- *Low-power options*
- *Based on AMD64 architecture*

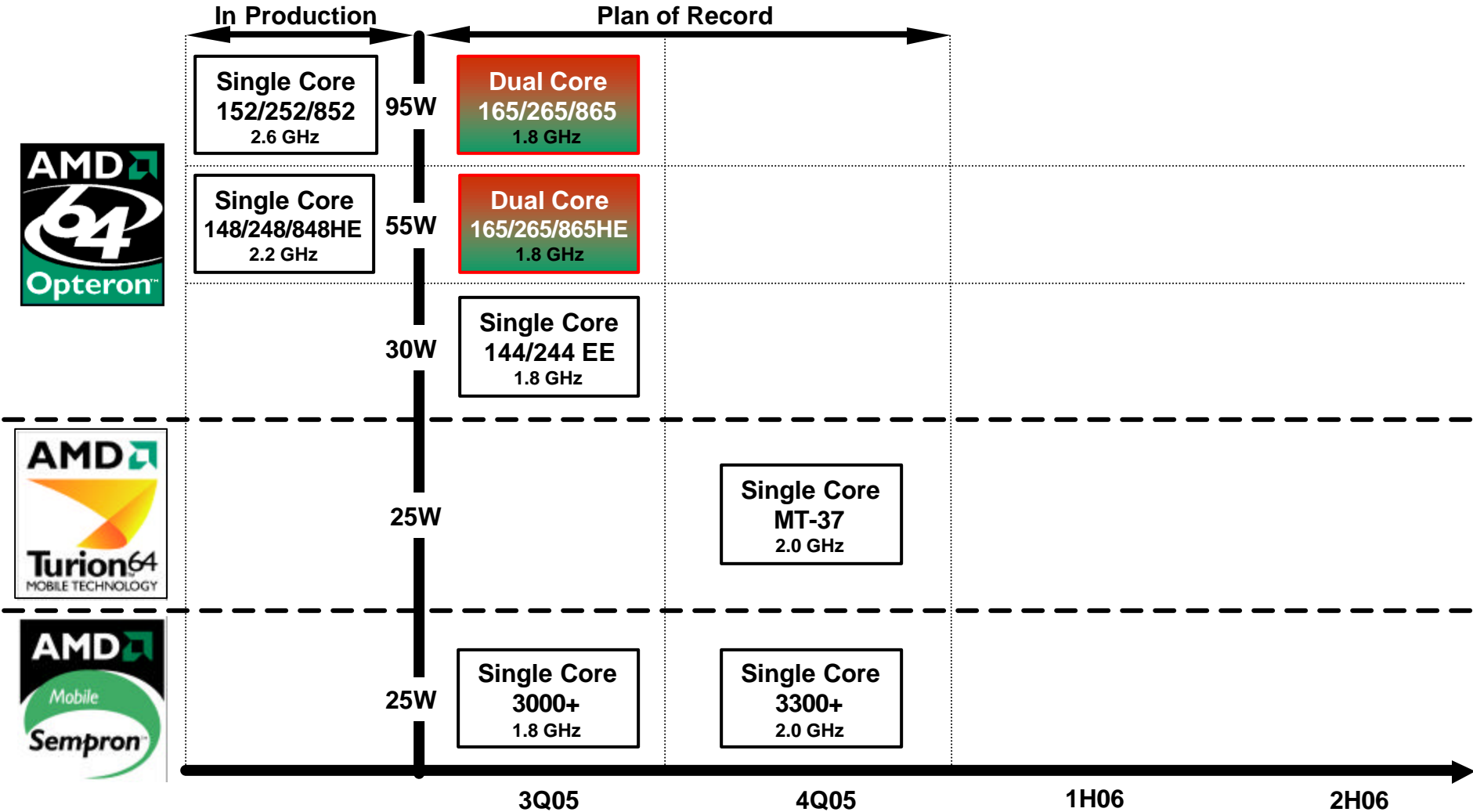
Positioning Statement

AMD Sempron™ processors uniquely leverage the AMD64 Direct Connect Architecture to deliver solutions for small footprint designs that require excellent compute & I/O performance.



Embedded AMD Processors

Product Roadmap—August 2005





Improved Thermal Specs for 30/55W Processors

Product Updates



Low-Power AMD Opteron™ Processors

30 and 55 watt AMD Opteron™ processors targeted at:

- Telecom applications (ATCA Blades, cPCI)
 - Storage applications
 - SBC
 - Military Applications
-
- These lower wattage processors are expected to enable platforms that must conform to specific lower power requirements.
 - One architecture for all AMD Opteron™ processor implementations
 - **SAME** 940-pin infrastructure for FULL and LOW Power products
 - Layout design, thermal solutions, software, etc.
 - 100 (UP), 200 (DP) and 800 (MP) processors available at 55W TDP
 - 100 (UP) and 200 (DP) processors available at 30W TDP
 - There is no performance penalty when using a lower power part.
 - **265HE** (55W) will perform exactly the same as a **265** Full power (95W)



Why Improve Thermal Specs?

- Telco (NEBS) Thermal Requirements
 - Tambient (Operating) 45C
 - Tambient (Qualification) 55C (96hours)
- Current AMD Opteron™ Thermal Specs
 - Tambient (Operating) 35C
 - Tcase (variable) 49 to 71C
- Customer Requests
 - Develop single cooling solution meeting both increased and regular thermal requirements
 - Single CPU able to operate in regular and increased temperature ranges
 - Reduce design cycle by simplifying cooling solution needs through relaxed case temperature specifications
- AMD Solution
 - Define specific AMD Opteron™ products with improved thermal specifications to help address increased thermal requirements.



Improvements to Low Power Roadmap

- Thermal improvements planned for 30 and 55W embedded processors in Q405
- Improvements are based on customer feedback
- All products will have NEW OPNs
- Updated specs will be released in product datasheet
- New products will be priced the same as current product
- Existing customers should transition to the enhanced products in Q405

Product Plan

Scheduled Date

Samples available

September 2005

Datasheet released

September 2005

Production plan

Late Q405

Specifications Plans

(Proposed Specifications – Datasheet will contain final specifications)



	55W Single Core (Standard Product)	55W Single Core (Proposed Product)
Package	940	940
Tcase	Variable	78C
Freq	2200MHz	2200MHz
Core Voltage	Variable	1.25V
Core Power	54.7W	40.3W
I/O Power	3.3W	3.3W
Throttling	Voltage + Frequency (PowerNow!)	Frequency Only (Cool'n'Quiet)
OPN's	OSK148FAA5BKE OSK248FAA5BLE OSK848FAA5BME	New OPNs

	55W Dual Core (Standard Product)	55W Dual Core (Proposed Product)
Package	940	940
Tcase	Variable	83C
Freq	1800MHz	1800MHz
Core Voltage	Variable	1.2V
Core Power	54.7W	51.8W
I/O Power	3.3W	3.3W
Throttling	Voltage + Frequency (PowerNow!)	Frequency Only (Cool'n'Quiet)
OPN's	OSK165FAA6CAE OSK265FAA6CBE OSK865FAA6CCE	New OPNs

	30W Single Core (Standard Product)	30W Single Core (Proposed Product)
Package	940	940
Tcase	Variable	71C
Freq	1800MHz	1800MHz
Core Voltage	Variable	Variable
Core Power	30W	30W
I/O Power	3.3W	3.3W
Throttling	Voltage + Frequency (PowerNow!)	Voltage + Frequency (PowerNow!)
OPN's	OSB144FAA5BKE OSB244FAA5BLE	New OPNs

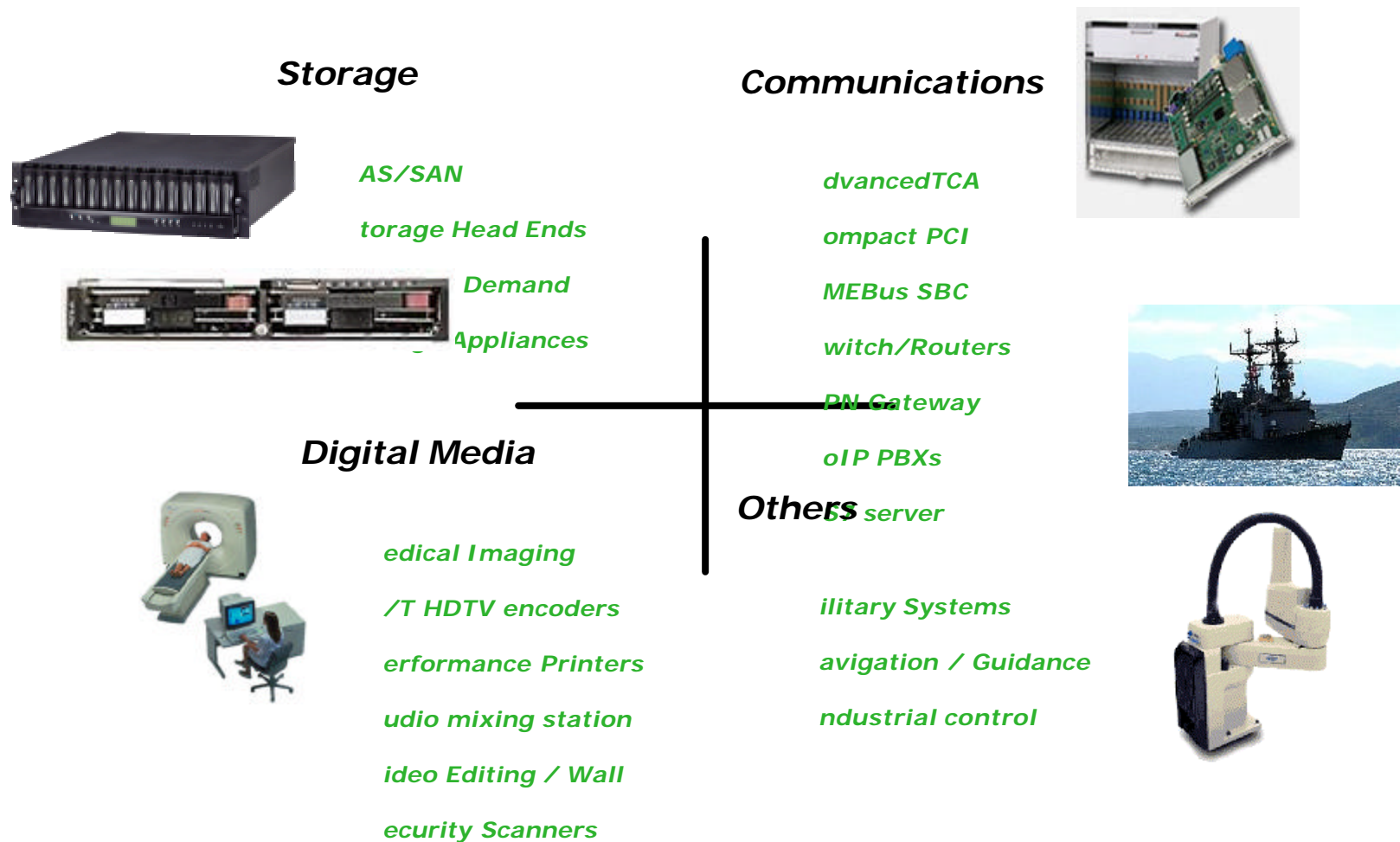
Key: -

NEW Specs

OLD Specs



AMD Direct Connect Architecture Target Markets



Storage



- **Applications:**

- Network Attached Storage (NAS)
- System Area Networks (SAN)
- Video on Demand Appliances

- **Market TAM for AMD64:**

- Marketing growth at double digit rate (15%)
- AMD64 TAM:
 - 2005 – \$410M (~150,000 processors)
 - 2006 - \$470M (~200,000 processor)
 - 2007 - \$520M (~350,000 processors)

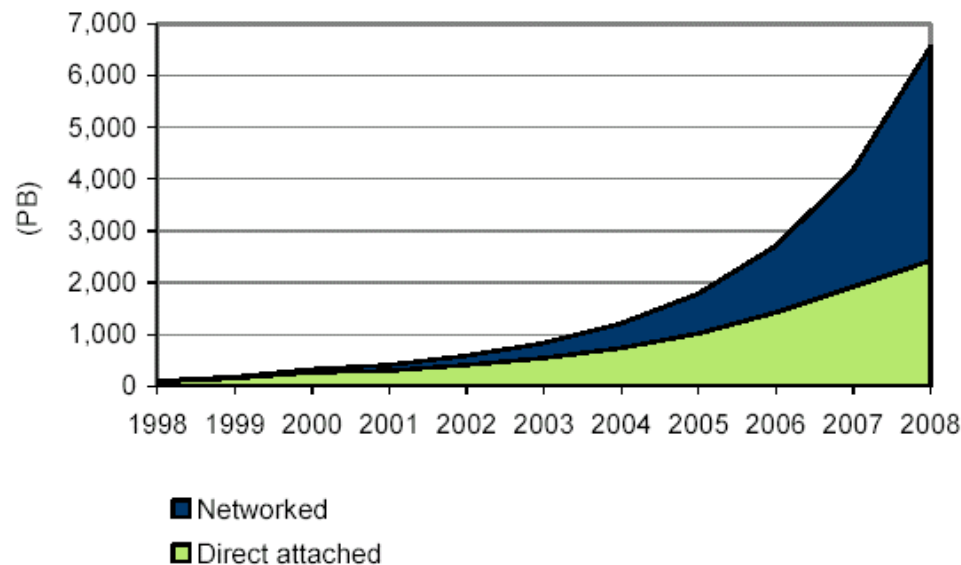
- **AMD64 Technology Advantage:**

- Memory system performance
- I/O performance & bandwidth
- Memory Reach (AMD64)
- Multi-processor scalability



Why is the market for storage exploding?

Worldwide Storage Deployments, 1998–2008



Source: IDC, 2004

IDC projects from 2003 – 2008

- DAS has a CAGR of 35%
- Networked storage has a CAGR of 70%

• Market Dynamics

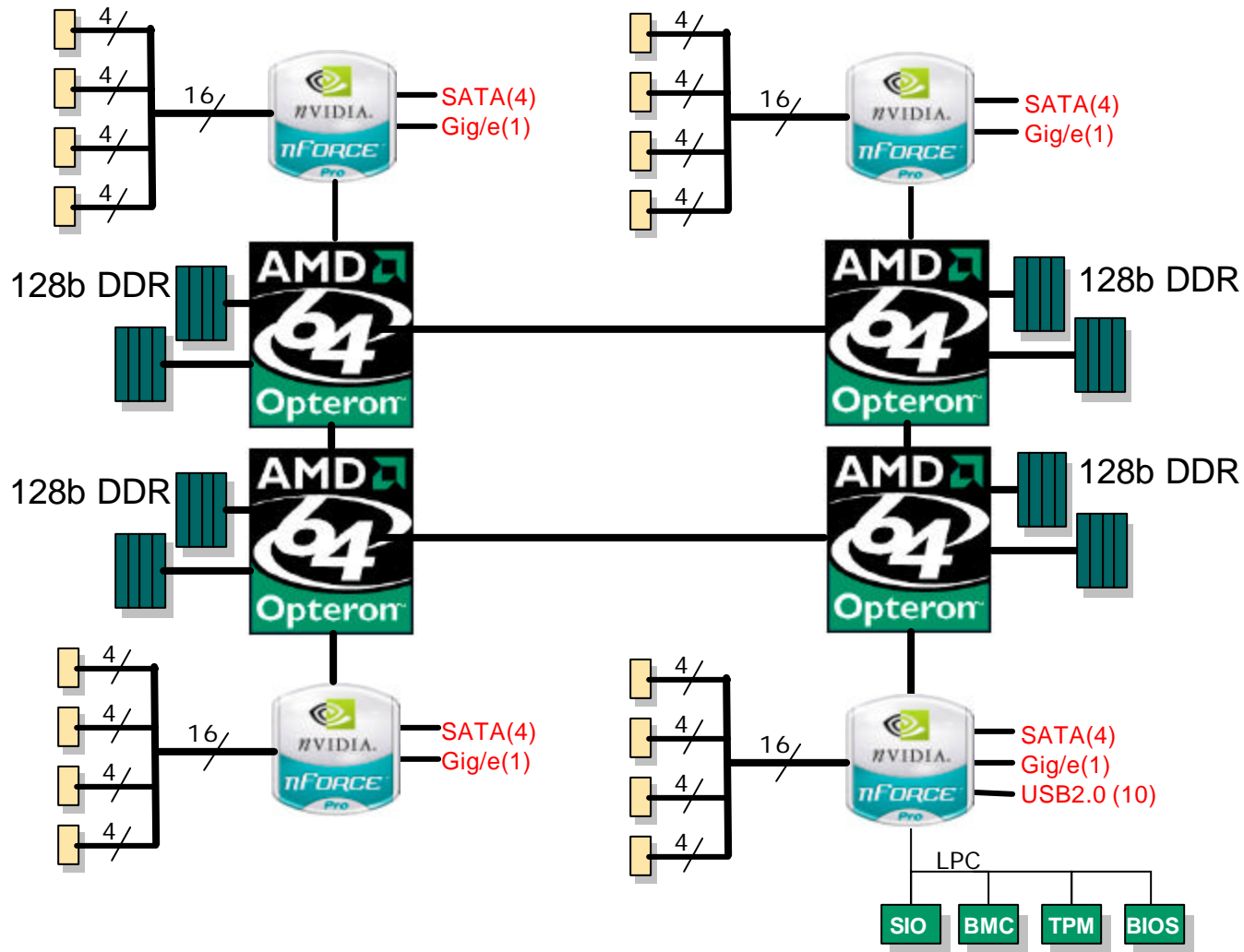
- Demand for raw capacity growing at >50% per year

• Storage Drivers

- Legislation / regulation
 - HIPAA, Sarbanes-Oxley, FDA part 11
- Digital media in business and home
 - Audio, photo, video
- Medical imaging
- Impending cross over in cost of disk versus tape
 - Expected in 2 to 4 years
 - With new product design cycles at 18 to 36 months, this is a "current opportunity"



Example Storage Server





Embedded AMD64 Ecosystem

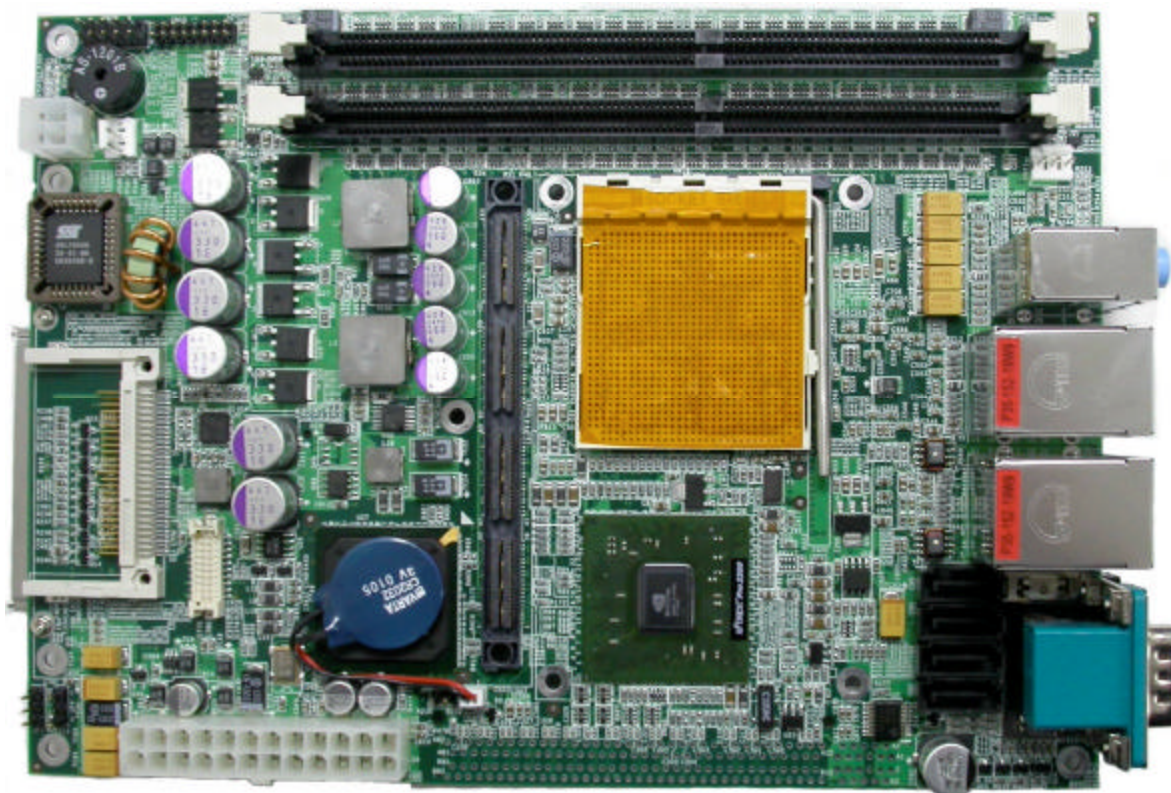
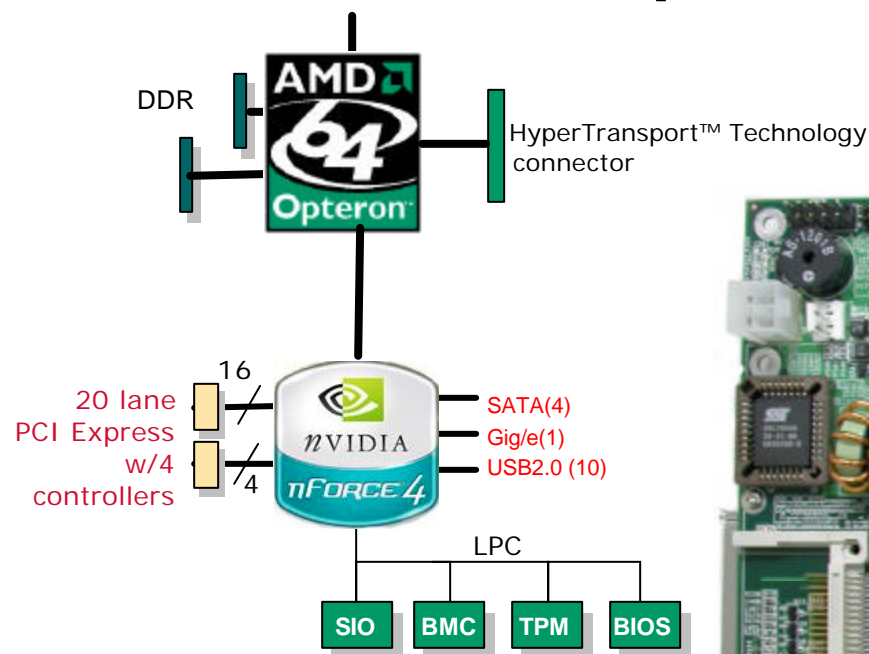
Embedded Ecosystem



- Reference Platforms / Boards
- Support ICs and HyperTransport Technology Bridges
- Operating System / Software Support
- Development tools
- Support Services
- Standards (VITA, PICMIG, HT Consortium)



1P AMD Opteron Processor SBC (Win Enterprise)



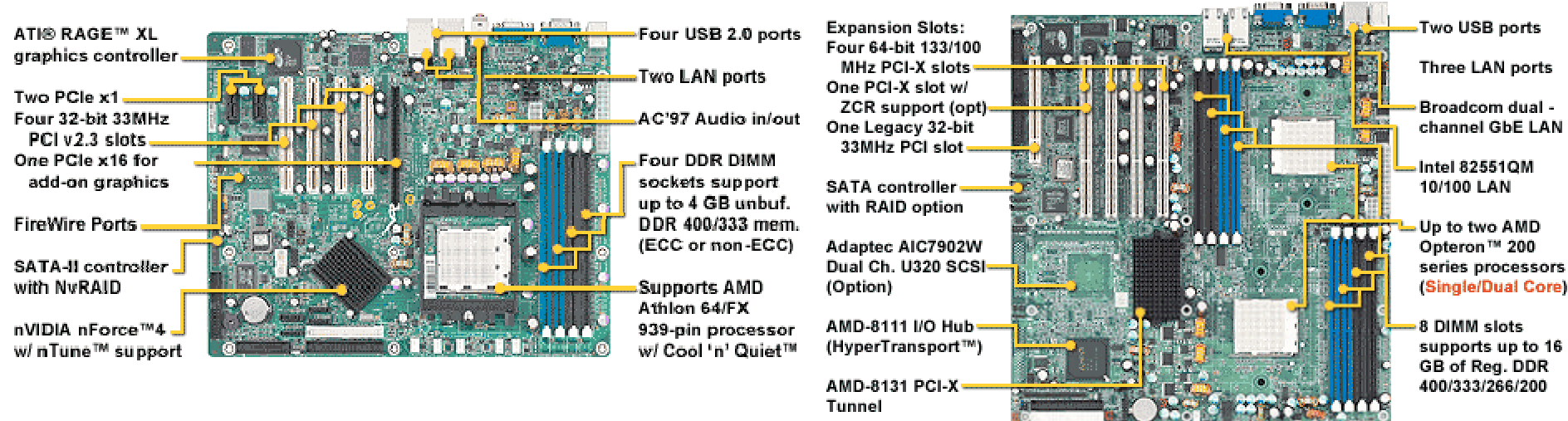
Win Enterprises

- EBX Single Board Computer
- Sampling now, production expected this quarter
- Win PICMIG 1.3 (cPCI – PCIe board)
- Alpha boards exist, expect production 4Q05



Reference Designs / Boards

- Tyan - 3 Year longevity product offering
 - Committed to support two platforms for 36-month longevity:
 - S2865 – 939-socket and S2882-D 2P 940 platform



Reference Designs / Boards

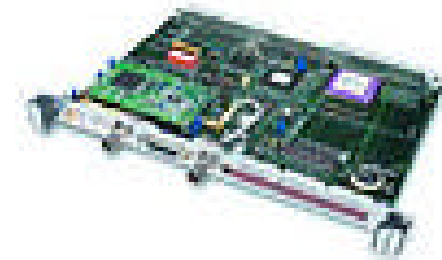
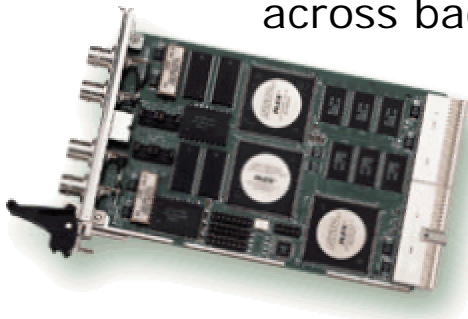


- Critia

- 1P 940-pin cPCI Reference platform – project name “Polaris”
 - Finished boards due in mid Aug.

- 1P 940-pin VME64-2eSST platform – project name “Regulus”
<http://www.critia.com/pdfs/Regulus.pdf>

- Blade based MP system -1P 940-pin VPX platform – project name “Castor” <http://www.critia.com/pdfs/Castor.pdf>
 - Similar to HP DL585 4P server. Processor and memory on blade, HT across backplane, separate I/O cards enable boot and system I/O.



Operating Systems



WIND RIVER

64bit Under development



AMD64 version ready (real-time Linux)



QNX SOFTWARE SYSTEMS

X86-32 version ready (validated on AMD platform)

- Solaris™, Windows™
Operating Systems are available and relevant to many embedded customers



AMD64 version ready



Under development

Embedded BIOS vendors supporting Opteron™ ...

Insyde Software also planning increased AMD64 Support



Extensive support available



Extensive support available



Initial Opteron Support Available

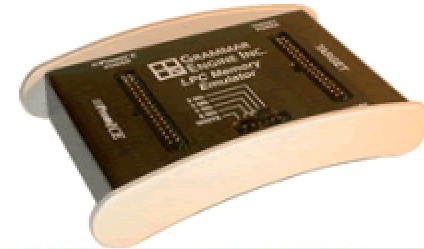


Limited features but cheap!



Debuggers, ICE & related tools

- LPC/BIOS in circuit emulator
 - MG Tech, Ohio USA
 - Phone: (614)899-7754
 - Fax: (614)899-6703
 - Toll Free: 1-800-PROMICE
- JTAG 1149.1 Boundary Scan Emulator
 - American Arium, Tustin, CA
 - Phone: (877)508-3970
 - Fax: 1-714-731-6344
 - www.arium.com
- Thermal Test Kits (TTK)
- CodeAnalyst™
- SimNow™



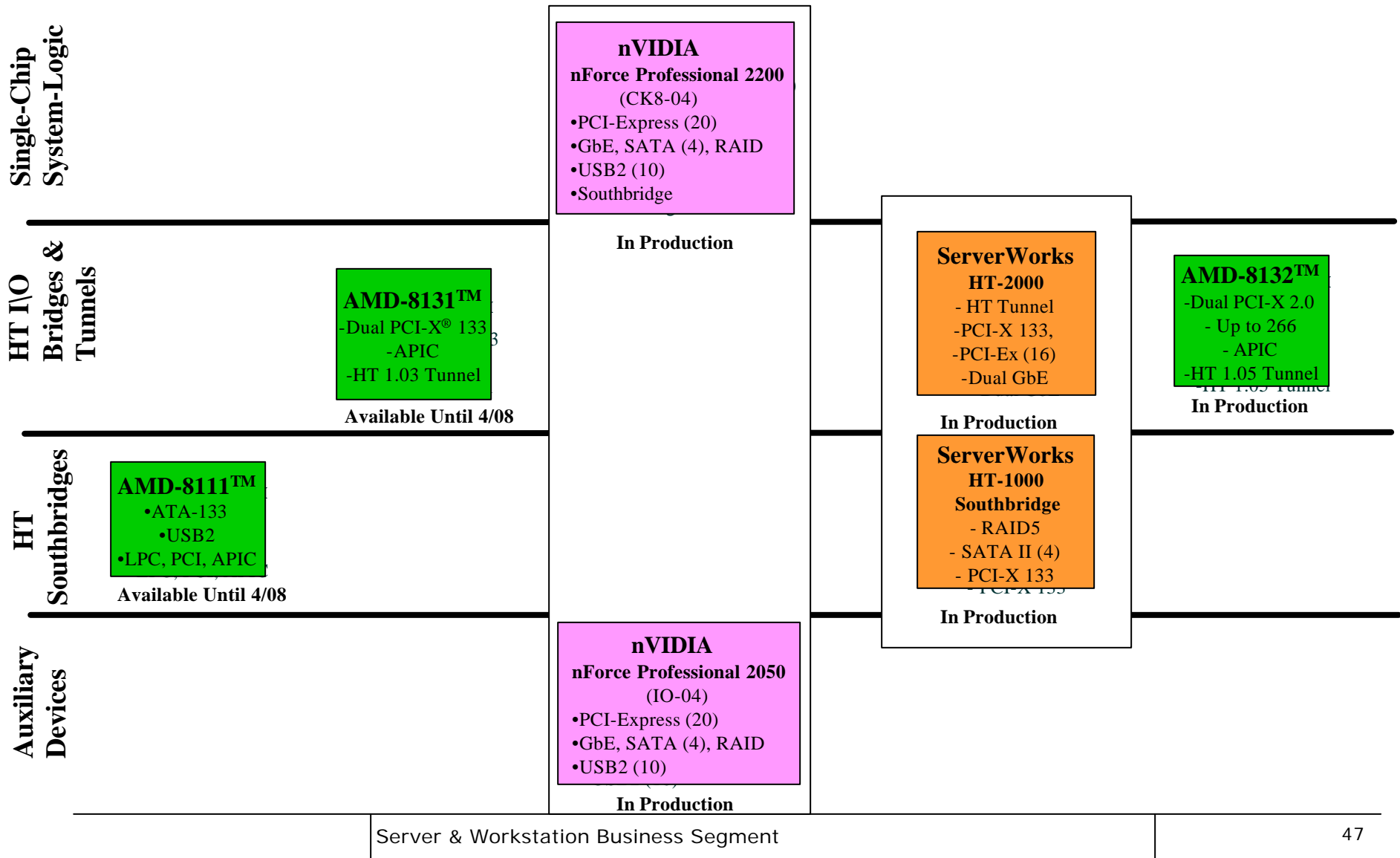
PromICE.com





Embedded Chipset Roadmap

Refer to your chipset vendor for specific information regarding product longevity.



HyperTransport™ Technology I/O Bridges and Related IP



AMD8132™ - PCI-X Bridge



AS90L10208 – PCI-X Bridge



Nitrox – SSL/IPSec Bridge



InfiniPath – InfiniBand Bridge



RS480 - SVGA Bridge
SB400 - South Bridge

On going discussions with ULI



- nForce Professional 2200 (CK8-04) South Bridge
- nForce Professional 2050 (IO-04) I/O - PCIe Bridge



K8T935 - South Bridge



- HT-1000 - South Bridge
- HT-2000 - PCIe Bridge



RapidChip™
Mask programmable ASIC



Stratix GX FPGA



VerTexIV FPGA



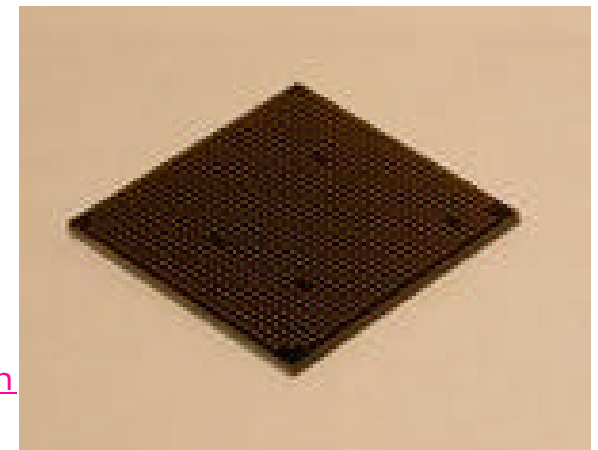
HyperTransport™
Technology IP
from GDA





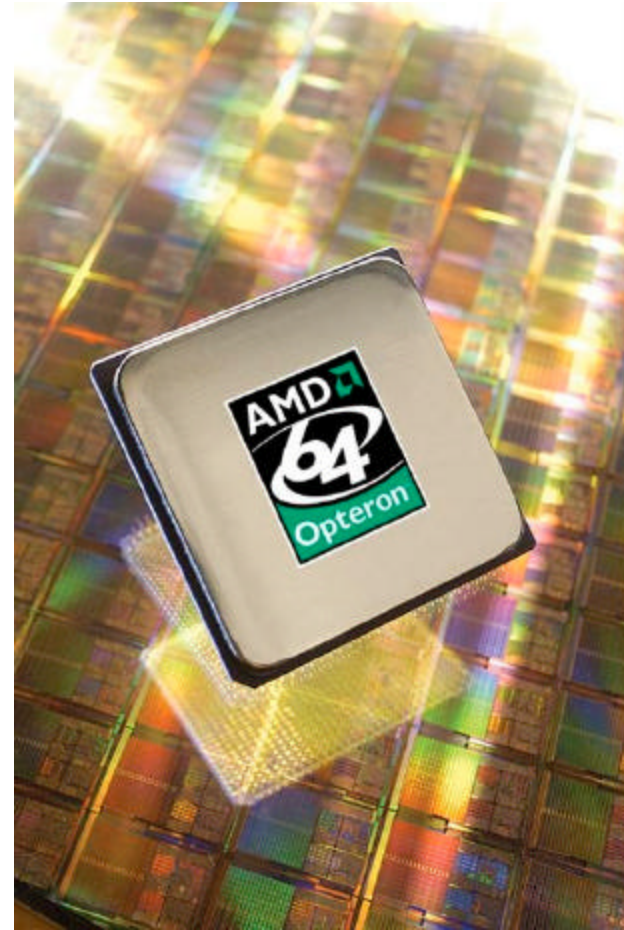
Special Purpose Sockets - 940

- Emulation Technology
 - Low profile 940-pin socket
 - <http://www.emulation.com/165/>
 - **High Density:** 1.27mm pitch
 - **High Speed:** 1 dB cut-off measured at 9.3 GHz
 - **High Reliability:** Proven dual-beam gold plated beryllium copper contacts
 - **High I/O:** 940 Pin
 - **High Speed Assembly:** Pick and place compatible
 - **Low Profile:** Socket height less than 2mm
 - **Low Insertion Force:** Less than 0.5 oz per contact (940 pin x 0.5oz = 29.4lb insertion force)
 - **CTE Compliant:** Designed to accommodate thermal mismatch
 - **Test Reports:**
 - [User Guide](#)
 - [Electrical Test Report](#)
 - [Test Report #201263A Qualification Testing](#)
 - [HiLo Socketing System 1MM Pitch, Application Specification](#)
 - [Product Specifications](#)
 - [Cross Section Photos](#)
 - [Stack-Up Drawings](#)



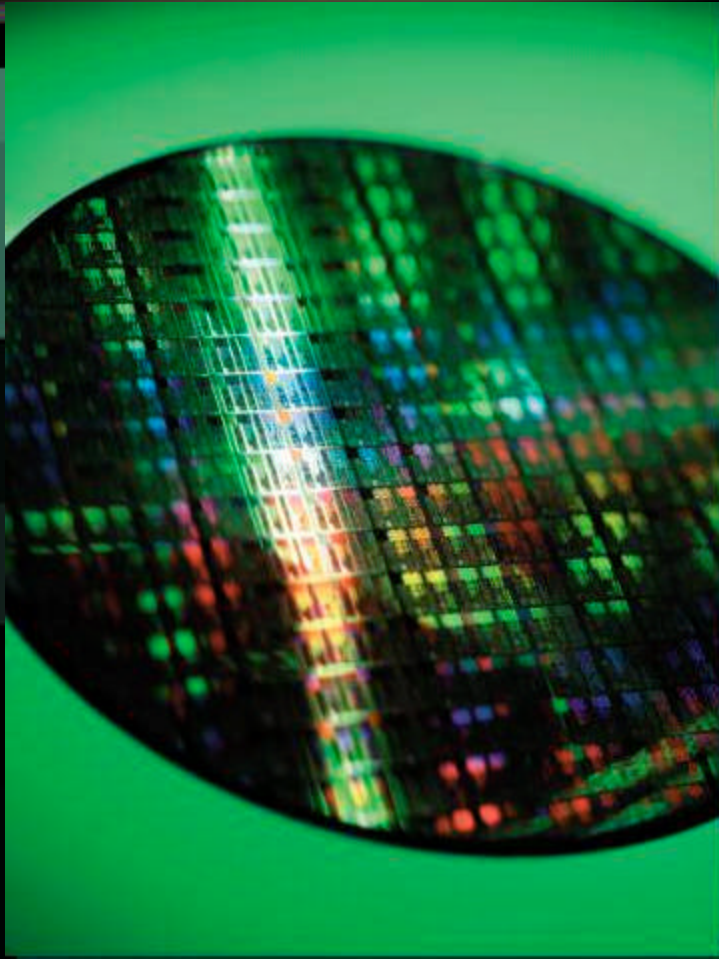
Conclusion

- The right time
- The right approach for high performance embedded markets
 - Get the architecture right.
 - Get the interconnects right.
- Innovation does not stop here.
- Users are ready.



Dual-Core AMD Opteron™ Processor





Thank You!